Zemdrain®

Technical Data Sheet

Controlled permeability formwork liner for high quality durable concrete surfaces

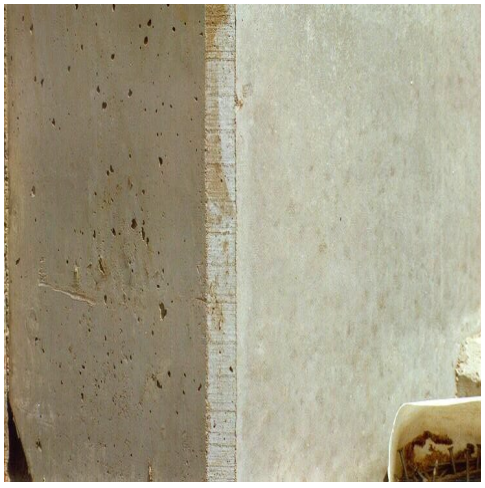
Uses

Zemdrain® is a thermally bonded polypropylene membrane that is placed to the internal face of formwork to provide a high quality durable surface.

The controlled permeability formwork liner provides a mechanism through which surplus water and air can migrate in a controlled manner resulting in a reduction in the formed surface water/cement ratio and porosity, thereby improving surface strength, durability and overall appearance of the concrete.

Application areas for Zemdrain® include:

- Water Containment Structures
- Waste Water Plants
- Marine Works
- Transport Structures
- Precast Elements
- Canals & Reservoirs
- Tunnels



Above photo shows concrete column where Zemdrain® was used with conventional formwork on the right hand side leaving an uncontaminated, blowhole free surface and on the left no Zemdrain® was used resulting in a blowhole and blemished surface.

Advantages

The use of Zemdrain® considerably increases the potential service life of all concrete structures. The benefits of replacing impermeable formwork coated in release agents with Zemdrain® are significant.

The benefits of Zemdrain® include:

- Reduced water/cement ratio
- Virtually blowhole free
- Surface uncontaminated by release agents
- Increased surface hardness
- Increased abrasion resistance
- Increased freeze/thaw resistance
- Reduced micro-biological growth and improved hygiene
- Reduced carbonation
- Reduced water and chloride ingress
- Proven economic benefits and cost savings over the whole service life

Description

Zemdrain® is a formwork liner with a controlled pore size to allow the passage of excess water and air from the concrete/ formwork interface, which is also designed to retain the majority of cement and other small fines.

Compaction energy and concrete pressure lead to drainage of a major part of the excess water contained in the outer concrete surface (~20 mm) of approximately 2.5 L/m^2. This not only optimises the w/c ration and decreases concrete porosity, but at the same time concentrates the finest concrete particles to give a cement rich surface area. Additionally, water retained in the formwork side of the liner is given back to the concrete during the curing phase.

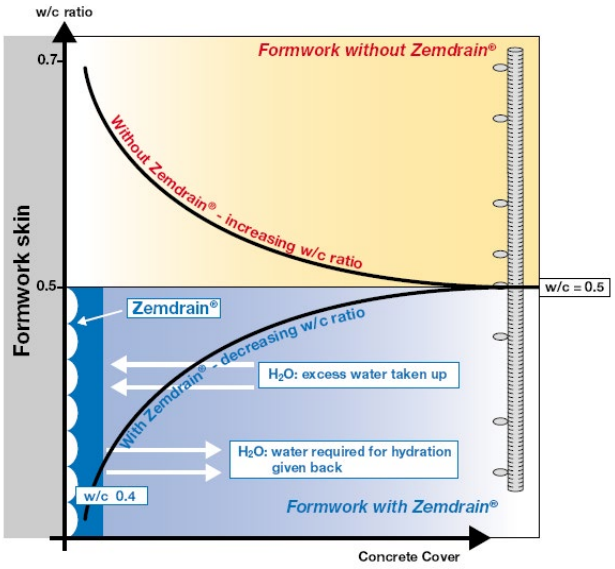
Zemdrain® - How It Works

Zemdrain® acts as the formwork face contact material. Both sides of the formwork liner are different and have unique functions.

The formwork side has a drainage/ storage function. It ensures that air and excess water are collected at the contact surface with the formwork and are removed using a textured surface with coarse fibres or a grid.

The concrete side, with its controlled pore structure, retains the cement fines, which leads to a denser and less porous surface. Zemdrain® only permits removal of excess quantities of water and air, and there is no vacuum effect. Water removal is by gravity, ensuring an ideal w/c ratio in the outer 20 mm of the cover zone. This encourages quicker and more complete hydration of the cement with reduced pore formation. The resulting higher concentration of fine constituents and cement reduce surface porosity and the formation of blowholes.

The result is a denser, more compact and more durable concrete cover zone, which protects the concrete core and the reinforcement from attack by aggressive elements.



With Conventional formwork, air and excess water in the concrete are expelled to the formwork surface by vibration energy. The result is blowholes, other surface blemishes, an increased w/c ratio and decreased cement content in the concrete cover zone. It is easier and quicker for harmful substances to penetrate this more porous concrete. Aggressive agents can begin their destructive work earlier and more intensively.

Formwork with Zemdrain® CPF liners remove excess water and air from the concrete surface in a controlled manner. Cement fines are retained at the surface. The result: an almost blemish free and low porosity surface with significantly reduced w/c ratio and increased cement content. The dense, hard, low permeability concrete in the outer cover zone gives improved protection to the reinforcement.

Technical Support

Parchem offers a technical support package to specifiers, end-users and contractors, as well as on-site technical assistance.

Properties

Surface strength

Measured according to BS1881 (pull-out test at 28 days). Up to five times stronger surface strength has been achieved through the use of Zemdrain®, due to optimum cement hydration.

Surface absorption

Two hours cumulative Initial Surface Absorption Test (ISAT) according to BS 1881, after 28 days. Surface of the concrete is up to ten times less permeable due to a denser structure and fewer capillaries left by evaporation of excess water.

Carbonation

Accelerated test, for 12 weeks, 4% CO_2, 50% RH, 23°C, at 28 days age. Up to ten times greater resistance to carbonation has been measured at the surface, as a result of the reduced porosity of the concrete cover. The surface of a C20 concrete cast against Zemdrain® formwork liner is more durable than that of a conventionally cast C50 concrete.

Chloride diffusion

Accelerated test, extrapolated according to the Second Law of Fick (at 28 days): AASHTO T227-831. When Zemdrain® is used, the time necessary to activate corrosion of steel reinforcement by reaching a specified concentration of chloride (0.4 % Cl/cement) is two to ten times longer.

Frost resistance

According to Swedish SS 137 244: freeze/thaw cycles with solution of sodium chloride. Thanks to a denser, less porous cover, up to one hundred times less material scaling has been measured on surfaces cast with Zemdrain®.

Curing effect

All properties of a concrete surface cast against Zemdrain® formwork liner, and left without cure in the lab, are better than those obtained on a surface cast again conventional forms followed by an ideal wet cure.

Application Instructions

Formwork

General

The finished concrete surface produced by Zemdrain® will be a reflection of the formwork used. For aesthetic applications the use of brand-new elements is recommended. The form face should be continuous, flat, clean and oil free. With lower grade plywood, the face should be sealed to prevent water ingress and extraction of wood sugars. Tape any joints where oil may have concentrated.

Appropriate formwork elements

All types of formwork elements can be used with Zemdrain®, but the method of installation may vary. Plywood and timber faced forms are the most suitable for use with Zemdrain®. Steel and plastic faced forms can also be used but they require special fixing methods.

Release agents

Release agents should not be applied to the formwork or to Zemdrain®. Take care to avoid all contamination. Where

release agents have previously been applied to the form face, this must be removed prior to Zemdrain® installation. This can be achieved by cleaning vigorously with a cloth and then jet washing or alternatively by sprinkling cement onto the surface and after the reaction has taken place brushing the residue off.

Formwork preparation

If the form face has visible raised nails, gaps or height differences between panels, old tie bolt holes, other defects or is not clean, then unless remedied these will be reflected on the finished concrete surface. Precautions should be taken to avoid any contamination of the surface of the installed Zemdrain® liner.

Joints between formwork elements to be lined with Zemdrain® must not exceed dimensions 1 – 2 mm. Any joints in excess of 2 mm should be sealed using an adhesive tape.

Tensioning and fixing Zemdrain® to the formwork

General

Zemdrain® requires tensioning over the formwork face to ensure that the liner does not move during concrete placement. The applied tension should be sufficient to allow for the expansive nature of the polypropylene and for any creep or relaxation that may occur.

It is recommended that tensioning is performed during the warmest part of the day as the liner will expand/contract when exposed to and shaded from the sun. The warmer the product the easier it is to tension. Lined forms should be protected from direct sunlight and from prolonged cycles of warming and cooling. For erected forms in direct sunlight, these should be allowed to cool down prior to concreting. Formwork should be erected in the normal manner. It is important that all assembled forms are held rigid to prevent unnecessary stress to the liner which may cause a reduction of applied tension.

Wherever practicable, rolls should always be fixed with the length direction of the roll in the vertical pour direction. A tensioning force of approximately 1.00 to 1.50 N /m is needed.

Stretching by approximately 0.3 to 0.6 % (equivalent to 3 – 6 mm/m – depending upon the air temperature) is required for the lengthwise direction of the roll. Stretching by approximately 0.1 to 0.3 % (equivalent to 1 – 3 mm/m – depending upon the air temperature) is required in the crosswise direction of the roll.

It is recommended that as short a time as possible is left between tensioning and first concreting (max.3 days). The tensioned material will relax with time and if the correct tension is not applied this can lead to fold imprints on the concrete. For longer periods of exposure the maximum tension should always be applied to the liner.

Fixing Zemdrain®

1. Forms should be raised off the ground and laid horizontally in both directions to avoid any mis-tensioning of the liner. Ensure that forms are sufficiently rigid.
2. Unroll MD and cut to the right size; length = shutter height (or shutter length), h + y + x. When using a Tensioning tool: x = 5 cm. When using a Tensioning frog or clamp: x = 25 cm.
3. Leave flat and exposed to the sun for at least 10 minutes to allow the liner to relax and expand.
4. Before stapling in position at the non tensioning end, ensure that the liner is lying square on the form.

   NOTE: The smooth white side of the liner is for the CONCRETE SIDE.
5. Always tension in the length direction of the roll first, which should preferably always be in the pour direction. A tension of 3 – 6 mm /m (depending on the air temperature) should be applied using our special fixing accessories.
6. The formwork liner must be tensioned simultaneously over the complete width.
7. Lengthways tensioning.

   Before applying the recommended tension take up the slack so that liner lies flat on the form.

   - Tensioning Tool – used for lengths of up to 2.5 m.
   - Tensioning CLAMP – used for tensioning length of up to 12 m.
   - Tensioning FROG – after unlocking it generates a permanent tension (for shutter lengths L = 2.5 – 5.5 m depending upon the prevailing air temperatures).
   - Stapling in position should be at 2 - 3 cm centres using 10 mm staples.
8. Crosswise tensioning

   Elongation of 1 – 2 mm/m is carried out simultaneously on both sides using a Tensioning tool at intervals of approx. 1 metre, alternating between sides. Stapling in position should be at 5 cm maximum centres using 10 mm staples. For optical reasons we would recommend to position the staples parallel to the shutter edge or even better outside the concrete surface.
9. If Zemdrain® MD is to be reused and depending upon tensioning method used, it may be necessary to protect the liner against excess elongation during stripping by having additional horizontal rows of staples at 1 metre intervals.
10. The liner can now be stapled down at the formwork edge. Alternatively to obtain the most aesthetic joint we would recommend that the grid and the filter be

separated and the excess grid cut off, the filter can then be stapled to the edge of the form or held in place with adhesive tape.

Use of stainless steel staples

Only use stainless-steel staples of the correct size. Staple sizes of 8 to 12 mm are appropriate depending upon the grade of Zemdrain® used and the hardness of the supporting plywood.

Protruding staples must be hammered home otherwise they may remain in the face of the concrete.

Reduction of visible imprints and load distribution

To avoid visible marks on the concrete surface, at tie bolt holes and under spacer blocks the maximum pressure on Zemdrain® should not exceed 2 MPa (20 kg/cm^2). Loading caused by reinforcement should be distributed onto as many spacers as possible.

We recommend the use of high quality fibre concrete spacers, distance tubes and stoppers. These should have the same compressive strength, durability properties and other characteristics as required of the concrete.

Joints between lines

Where butt-joints are unavoidable on the formwork face, the two strips should be overlapped by approx. 2 – 3 cm. Then both strips should be cut through together along one line and the off-cuts removed.

Both Zemdrain® formwork liners must butt together and they must be fixed with staples. Staples should be positioned parallel to the cut edge for optical reasons.

After fixing Zemdrain® to the formwork

Tie bolt holes should only be made after Zemdrain® has been fully tensioned and fixed to the formwork. To form tie bolt holes make a cross-shaped slit and then form the hole using a blade cutter. For extra safety, a few staples can be used to secure the liner in place at the locations.

Larger surface repairs

Damaged areas should always be replaced. For larger surfaces place a new piece of Zemdrain® over the damaged area and cut through both layers to form an infill section. Remove the damaged liner and replace with the new piece using staples.

Concreting

General

Concrete should be designed, placed, compacted and cured in accordance with accepted good practice and to the usual local guidelines. If concrete mixes with special cements such as Terrament or micro-silica are to be used, please discuss this with our technical advisory service.

Concrete should be placed and compacted in accordance with accepted good practice. Pouring and vibration of concrete should be performed consecutively without delay. Ensure that concrete is not discharged against the liner surface, splatter can be minimized by using a tremie tube or pumping. Also, avoid concrete wetting the surface of the liner and then being allowed to dry out. Failure to observe any of the above may result in prominent pour lines, colour variations, segregation or the presence of blowholes. Splashes of cement laitance against Zemdrain® caused by poor placement techniques can completely or partly prevent discharge of air and water through the liner.

Compaction with an internal vibrator

Primary vibration must be performed using an internal poker vibrator. External vibrators should only be used after completion of the pour and of primary vibration. The vibrator should be kept at a distance of at least 5-10 cm from the form face. Also ensure that fast extraction of the vibrator and excessive and irregular vibration are avoided. Some blowholes and lighter coloured concrete can occur in the upper 5 -10 cm of a pour. This can be minimized by re-vibration of this zone (after 20-50 mins), followed by tamping and smoothing of the surface. Another possibility is to surcharge the surface.

Zemdrain® cast concrete will generally be slightly darker than traditionally cast concrete reflecting the colour of the cement and the curing effect of the liner. Additionally, surface colour variations may also occur due to variable vibration, plywood quality, the mix used and the number of uses of the liner. These colour variations do not effect concrete quality.

Cleaning and reuse

To maximize the life and performance of the liner it is recommended that the liner be jet washed between uses. Particular attention should be paid to the upper 25% of the form, which should get an extra pass of the jet wash with a pressure of 3,00psi.

The reuse of the liner depends upon many factors, including proper tensioning, handling, stripping time and cleaning. Always check for mechanical damage between uses. Due to the above the absolute number of uses cannot be guaranteed, but experience has shown that with due care and attention 2 to 3 uses are common. It is recommended that the liner should not be used more than 4 times.

Limitations

Zemdrain® cast concrete will generally be slightly darker than traditionally cast concrete reflecting the colour of the cement and the enhanced curing effect of the liner.

Surface colour variations may also occur due to variable vibration, plywood quality, the mix used and the number of uses of the liner. These colour variations do not effect concrete quality.

In times of high daily/weekly temperature variations (> 10°C), care is required to ensure that the liner remains under the

correct tension and folds are not formed.

If the specially designed fixing accessories are not used there is an increased risk of fold formation. When using Zemdrain® at low temperatures or with heated concrete, it is recommended that the liner be kept in a warm environment prior to use and that additional rows of staples be added at 1.0 m intervals over the form height.

We cannot accept liability for insufficient adhesion of adhesive tapes on formwork and Zemdrain®. In addition, use of the adhesive tape impedes outflow of the air and drainage water and this can cause isolated small blowholes on the concrete surface.

Zemdrain® tapes and other adhesive tapes do not have specific approval for their use in the construction of drinking water reservoirs, please check with local regulators regarding suitability for use.

Always wear protective gloves to avoid cuts caused by sharp edges or during cutting work. You should avoid heavy mechanical friction to the concrete side of Zemdrain® formwork liner, as this can lead to separation of the individual surface fibres. The risk of damage to the liner, which can occur when the shutters are being erected can be minimized if the lined shutters are stored vertically.

Supply

Roll width:	2.50 m
Roll length:	35.0 m
Roll thickness:	2.2 mm thick
Roll weight:	59 kg

Coverage

87.5 m^2 per roll

Storage

Opened and unopened rolls of Zemdrain® should be stored in a clean environment, away from contaminants and prolonged exposure to UV light. In cold weather, rolls should be stored indoors. Zemdrain® should be protected from flames, welding or steel cutting and kept free from dirt and dust.

Zemdrain® consists of 100% polypropylene and belongs to the polyolefine disposal category which is ecologically harmless. After carefully removing the used liner and staples from the form face, the liner can be used for protection of or as a drainage fabric on underground walls or beneath floor slabs. If this type of re-use is not possible, then as the liner is chemically inert it can be safely disposed of by burying, earth dumping or incineration.

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